Space Weather Technical Forecast

Issued on Saturday, 22 October 2022 at 13:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: G1/Minor to G2/Moderate Storm likely, mainly Day 2 (23rd)

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity over the past 24 hours has been Low, with several, mainly small C-class flares observed. A C6 flare at 22/0542 UTC was from AR3122 that has rotated over the northwestern limb. There are currently four sunspot regions on the visible Sun, however these are all currently small and simple regions. The central disc dimming observed early on the 22nd has not produced a visible CME, with no other Earth-directed CMEs observed.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, has been at background levels throughout, on a slowly declining, then steady trend. The density of the wind, however, exhibited a gradual but also erratic rise, from average levels to above average levels around 12-18ppcc by 22/0000 UTC, further increasing to around 17-20ppcc by 22/1200 UTC. The total IMF strength, Bt, also erratically rose from being weak at 5-7nT to peak at moderate values of 10-12nT. The north-south component Bz was mainly weakly positive, however, became more generally moderately negative from around 22/0700 UTC. A peak value of -11nT was observed at 22/1109 UTC. The phi angle has been positive (away from the Sun) throughout. Geomagnetic activity was Quiet with isolated Unsettled intervals, but became Active (Kp4) between 22/0900-1200 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 has remained at Background levels. High energy electron flux (greater than 2MeV) at GOES16 was initially Moderate, but very briefly reached High levels, with a peak flux of 1160pfu recorded at 21/1555UTC. Since 21/2300 UTC electron flux has almost exclusively been at normal background levels. The associated 24-hour integrated fluence was below the Active (1e8 integrated pfu) threshold, with 3.29e7 integrated pfu observed at 22/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is most likely to continue Low, perhaps falling to Very Low, but with a slight chance of isolated M-class flares.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs currently feature in the forecast period. Solar winds are expected to see a gradual transition into the fast wind of CH34 on day 1 and into day 2 (22nd and 23rd), with solar winds most likely to Elevated to Strong, with a slight chance of becoming Very Strong. This is low confidence in respect to both timing and strength, and is mainly guided by current enlil expectations as well as a notable enhancement observed by STEREO A. The fast winds will likely persist into day 3 (24th), before potentially easing day 4 (25th). Geomagnetic activity is expected to be Unsettled to Active with an increasing chance of G1/Minor to G2/Moderate storms either later day 1 or more likely day 2 (23rd). Quiet to Unsettled with isolated Active intervals are then expected day 3 and day 4 (24th and 25th).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) is expected to be at Background. High energy electron flux (greater than 2MeV) as observed by

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GOES16 is expected to peak at Moderate, perhaps briefly High levels on day 1 (22nd) before dropping out with any fast wind arrival later or on day 2 (23rd). A gradual rise to mainly High levels is then expected by the end of the period. The associated 24 hour fluence is expected to remain below Active (1e8 integrated pfu) at first, before rising late in the period, with a chance of rising above day 4 (25th).

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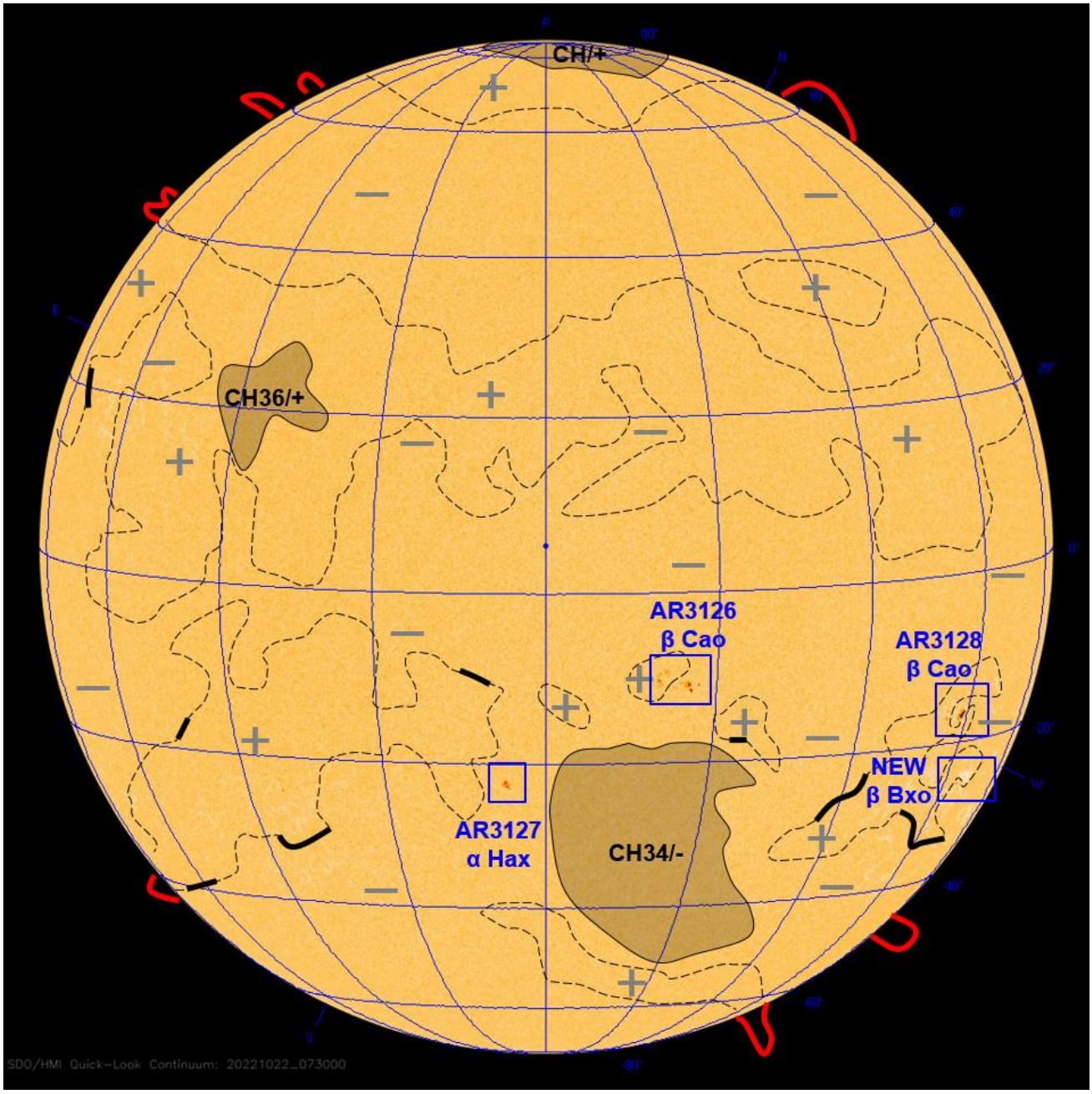
Figure 1. Solar Analysis Valid 22/0730 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-directed CMEs currently feature in the forecast period. A coronal dimming associated with a C1 flare at 21/0408 UTC near the centre disc in the southern hemisphere may have resulted in a slow CME that could have an Earth-directed component, however, there is no clear evidence in available imagery for any CME. If anything were to be observed at Earth it would likely be around the 26/27th (currently outside the forecast period), but probably bring very limited impacts.

The main feature of interest for this forecast period is the large southern negative polarity CH34. This is a recurrent CH with similar appearance to the previous rotation and, with persistence indicating an arrival on day 3 (24th), and resultant solar wind speeds of 550km/s. Conversely, however, MOSWOC enlil is indicating an arrival on day 1 (22nd), with solar winds peaking at 600km/s early day 2 (23rd). The latter of these is currently accepted as most likely, given current observations at STEREO A.

STEREO A, which samples the solar wind around 1.4 days before it reaches Earth, already observed a significant increase in both density (peaking near 295ppcc), and total magnetic field (Bt) approaching 25nT. The solar wind showed a significant increase around 22/0000 UTC, possibly up to 700-900km/s, although solar wind data has been very sparse since then, reducing confidence in the validity of this. A potential reason for this increase, would be that STEREO A (which is currently north of the ecliptic), had encountered a prolonged period in the CIR of CH34, as it passes through the northern boundary between the CH fast wind and the surrounding background slow wind. Then finally transitioning into the fast wind of the CH more recent times. Alternatively, there remains the possibility that a passing, weak, transient CME is the cause of this enhancement however no potential candidates for this have been observed.

Consequently solar winds at Earth are expected to remain near background speeds until later on day 1 (22nd), before a significant enhancement into day 2 (23rd), likely reaching speeds of around 550-700km/s and a slight chance of reaching up to 900km/s. These Elevated to Strong winds (perhaps briefly Very Strong) will likely persist day 3 (24th), perhaps gradually easing day 4 (25th).

Geomagnetic activity is expected to be Unsettled to Active with an increasing chance of G1/Minor to G2/Moderate storms either later day 1 or more likely day 2 (23rd). Quiet to Unsettled with isolated Active intervals are then expected day 3 and day 4 (24th and 25th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	50	90	20	1
Strong	G3	No	1	10	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections - Nil

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Figure 2: Solar wind persistence model showing arrival of fast wind from CH on 24th.

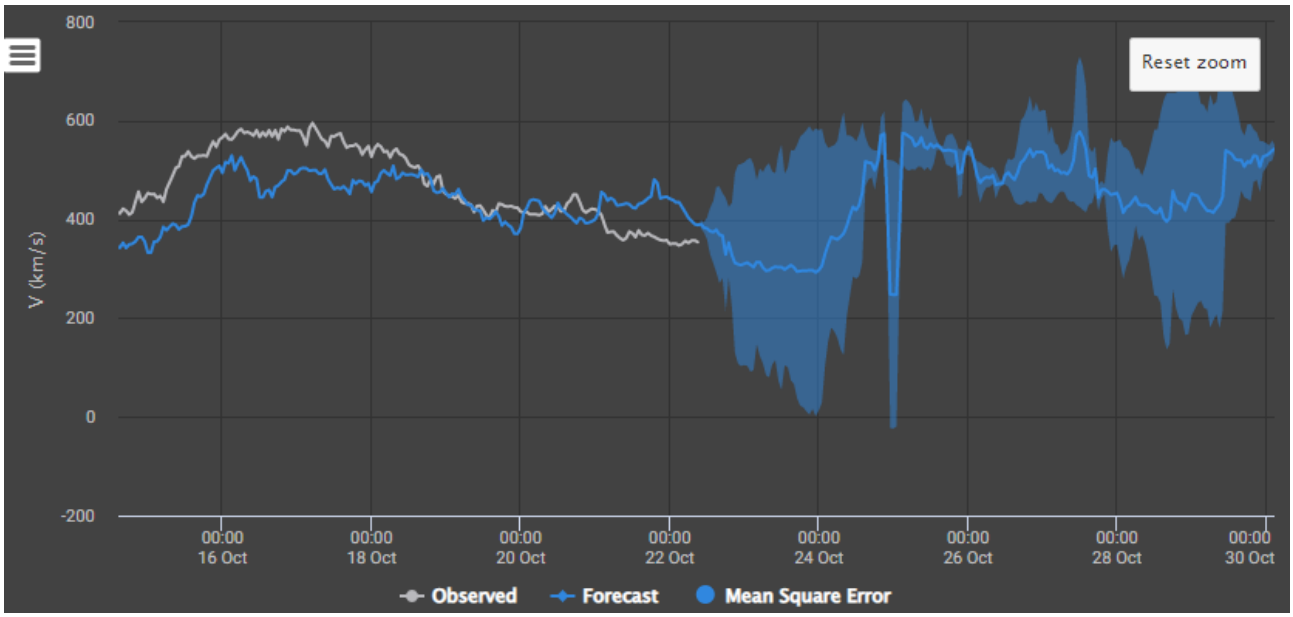
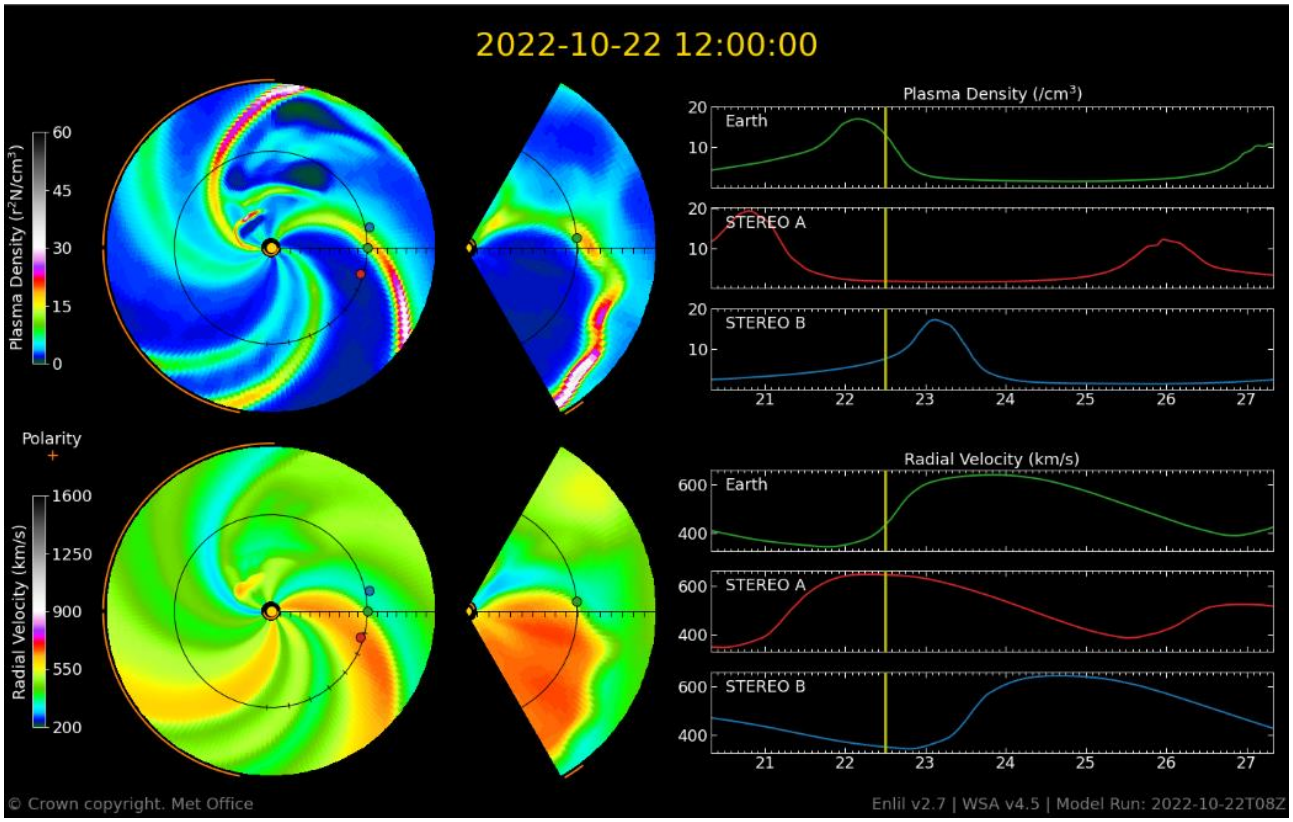


Figure 3: Latest Enlil forecast indicating arrival of fast wind from CH on 22nd.



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Radio Blackouts - X-Ray Flares:

Solar activity is currently Low, with four sunspots on the Earth-facing disc. Low activity is expected to continue, perhaps falling to Very Low, but with a slight chance of increasing to Moderate levels.

All four sunspot regions on the visible disc appear relatively small and simple, although a 'new' region in the far southwest, near AR3128, has developed in recent hours and may be more complex than Bxo/Beta it was previously assessed as. However, as it approaches the western limb it will become increasingly difficult to assess in available imagery. AR3128 (Cao/Beta) appears broadly similar to before, though with some weak spot proliferation to the rear of the group. AR3125 Cao/Beta and AR3127 Hax/Alpha are more persistent areas closer to the southern centre disc, but both remain small and stable with simple magnetic structure. Elsewhere there are a number of faint spots in the southern hemisphere, but not significant enough to warrant including at present in assessments.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	10	10	10	10
Very Active	R3 to R5 X Class	No	1	1	1	1

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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES16 is currently at Background and expected to stay at this level.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as observed by GOES-16 has been varying between background and Moderate, perhaps briefly high levels, for a number of days, and little change is expected day 1 (22nd) before the arrival of the fast wind of CH34. There is significant uncertainty on both the timing and strength of this arrival, and hence in any subsequent increase in the observed electron flux. As solar wind pressure likely eases through day 3 and day 4 (24th and 25th), flux levels are likely to rise and are expected to become mainly High by the end of the period.

The associated 24 hour electron fluence is expected to remain below Active, but rising late in the period, especially as solar winds ease. There is a chance of Active fluence by day 4 (25th). REFM is providing good guidance until T+24, but should be used cautiously beyond this due to the potential earlier fast wind arrival compared to persistence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	20	40
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	2	5

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Figure 4: GOES-16 >2MeV Flux and fluence with REFM

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